

chromosomes were clumped together into what appeared to be trivalents, and at other times pairing failed causing several univalents to be present at diakinesis. The chromosomes of citrus are very small and it was almost impossible to distinguish between large bivalent and trivalent chromosomes. It was only from such clear figures as are pictured that satisfactory counts could be made. Many counts, however, have assured me that the plant studied is a trivalent citrus and represents a cross.

A few tetrads were studied (figure 1 D) in order to determine the prevalence of polypory. It was found that about 17 per cent had five and 1.5 per cent had six grains in a pollen tetrad. These counts and the presence of only a small percentage of abnormal appearing grains in mature pollen indicate that very little irregularity in chromosome distribution occurs during meiosis in this triploid plant.

The finding of this triploid hybrid shows that it is possible to produce triploid citrus by appropriate crosses. It is, moreover, hoped that in this or similar crosses the much desired seedless Kumquat will be produced.

BOTANY.—*New species of cotton from Colombia and Ecuador.*<sup>1</sup>

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The wealth of natural forms in the genus *Gossypium* receives further illustration in new types of cotton plants collected recently in several localities on the west coast of South America, in Colombia and Ecuador. The native cottons of this region apparently are not closely related to the series of Mexican species described in this JOURNAL under date of June 19, 1926, but show other peculiar characters not previously recognized among the species of *Gossypium*.

The new features include specializations of the involucre bracts and extrafloral nectaries, as well as of the leaves, bolls and seeds. One of new species has involucre with the margins of the bracts turned outward, so that the buds and young bolls are exposed, while another has very small involucre, and very narrow bracts, with only 3 to 5 teeth. In striking contrast with such involucre, other South American species have very large many-toothed bracts, cordate at base, with broad auricles united along their inner margins or overlapping across the pedicel. Other outstanding features are very large and prominent involucre nectaries, large auriform crests or expanded bractlet-like organs surrounding the base of the calyx, bolls

<sup>1</sup> Received Oct. 16, 1926.

with large numbers of seeds per lock, bolls with only 2 locks, the absence of simple or 3-lobed leaves, and pubescence of simple hairs, instead of the stellate pubescence usual in *Gossypium*. Descriptions of some of these characters, with natural-size photographs of their occurrence in the different species, have been prepared for the Journal of Heredity, to follow the paper on characters of new cottons from Mexico which is being printed in the Journal of Heredity for November, 1926. While most of the tropical cottons are not adapted to conditions in the United States, it is of interest and importance to breeding to know the range of characters represented in the genus.

The need of basing botanical descriptions of cotton plants on the living material, growing under conditions of natural adaptation, as explained in the previous paper, becomes still more obvious after the study of these South American forms. Some of the most striking and distinctive characters could not be recognized or described from dried specimens, though some can be shown in photographs. Several important differences of leaves and involucre must be treated in three dimensions, not merely in terms of size and outline. The pressing of the specimens obliterates some of the most distinctive positional features.

Some of the native cottons of the northern districts of Peru were described by Richard Spruce,<sup>2</sup> in a paper published in 1865, but the species were not named and apparently are not the same as those here described. No other botanist appears to have observed and recorded the characters of cotton plants in South America from living material.

#### KEY TO SPECIES HERE DESCRIBED

Involucral bracts very small and narrow, with a strong flexure or stand-off at base and with few marginal teeth, only 3 to 5; bolls mostly 4-locked, nearly round, the apex blunt or retuse, surface nearly uniform light green, the oil-glands deeply immersed in the green tissue; pubescence of simple hairs; seeds fuzzy: *Gossypium tridens*.

Involucral bracts large and broad, with a slight basal flexure, marginal teeth numerous, 9 to 19; bolls mostly 3-locked, oval, ovate, or fusiform, acuminate or apiculate, deeply pitted, exposing the black oil-glands distinctly; pubescence of stellate hairs; seeds nearly naked after removal of lint, the fuzz very thin or confined to small tufts or bands. . . . .

Involucres with small nectaries, located in slight depressions; leaf nectaries small, usually confined to the midvein even on large 7-lobed leaves of the main stalk or vegetative branches; fruiting branch leaves all 5-lobed; bolls oblong-oval, abruptly acuminate, the surface even, the oil-gland punctations small and scattering: *Gossypium quinacre*.

<sup>2</sup> SPRUCE, RICHARD. *The culture of cotton in northern Peru*, The Technologist, May 1, 1865, pp. 431-445.

Involucres with large, prominent nectaries; leaf nectaries often large, commonly 3 on large 5-lobed and 7-lobed leaves of the main stalk and vegetative branches; fruiting branch leaves commonly 3-lobed; bolls conic-oval, acuminate, the surface irregular with large pits which are often crowded or confluent.

Involucral bracts with margins strongly everted, exposing the buds and young bolls; seeds with lint confined to the upper half or two-thirds of the surface, and with little or no fuzz except in a short band in the lower part of the lint area: *Gossypium evertum*.

Involucral bracts with plane margins, inclosing the buds and young bolls; seeds with tufts of fuzz at the base or apex.

Inner nectaries large, longer than broad, connected by large auriform processes or crests extending around the base of the calyx; auricles of bract moderately developed, united at base, not overlapping the pedicel: *Gossypium calycotum*.

Inner nectaries broader than long; not connected by processes or crests, rarely subtended by narrow bractlets; auricles of the bracts very large, the inner margins curved inward, overlapping across the pedicel, forming circles around the outer nectaries; bolls ovate-oblong, abruptly acuminate: *Gossypium auritum*.

#### *Gossypium tridens* sp. nov.

Plant large and tree-like, about 15 feet in height with an erect trunk 4 inches in diameter at base, light green open foliage, and rather long fruiting branches, the numerous short joints bearing small rounded bolls, often with 6 to 8 bolls on a branch.

Leaves small, simple or with 2 to 5 lobes, usually 3-lobed on vegetative branches and 2-lobed on fruiting branches; simple and 5-lobed leaves very few; lobes rather long, narrow, acuminate; midlobe<sup>3</sup> slightly constricted, upfolded around the sinus; forelobes usually unequal, one often twice as large as the other; auricles very short, the basal sinus open; callus strongly decurrent; surface of leaves entirely glabrous, with a fringe of hairs on the margins and scattering hairs on the larger veins above and below; petioles and young branches rather densely pilose; hairs mostly simple, rarely two or three together, instead of stellate; pubescence very persistent, remaining on the year-old wood; length on the midvein of large 5-lobed leaf 16 cm., on the greatest expansion of auricle 17.5 cm., width on points of forelobes 23 cm., on points of sidelobes 13.5 cm., length of petiole 9.5 cm., leaf nectary single, rather small, with prominent rim, oval or ovate, about 1 cm. from base of vein; stipules fugacious, small, falcate, about 1 cm. long, 1 mm. wide at base those of fruiting branches shorter and broader.

Involucral bracts very small and narrow, sublanceolate, slightly auriculate, with strong flexures or off-sets at base; usually free, but sometimes connected for about 1 mm.; teeth usually 3, sometimes 4 or 5, the median tooth as long or longer than the body of the bract, with one or two small teeth on each side; bractlets not present; pedicels cylindrical, short, solid, triangular only near receptacle. Outer nectaries broadly oval or transverse, sunken; inner nectaries very broadly triangular, often reduced to a transverse slit. Calyx very short, with shallow rounded lobes; flowers not seen.

<sup>3</sup> To designate the successive lobes of the leaves, beginning at the middle, the terms midlobe, forelobes, sidelobes and backlobes are used. The principal veins of the lobes are designated correspondingly as midvein, foreveins, sideveins and backveins.

Bolls small, usually as broad as long, subrotund, abruptly narrowed to a blunt point or with a small apical depression; fissures deeply marked at the tip, the divisions bulging beyond the insertion of the stigma; surface smooth, light green, with shallow punctations, the oil-glands deeply immersed; locks 3 and 4, usually 4, seeds per lock 5 to 7.

Seed small, densely covered with long greenish fuzz; lint white, about 1 inch long, fine and silky, not fluffing out.

Type in U. S. National Herbarium nos. 1,282,030, 1,282,031, and 1,282,032 collected from the same plant at Buenaventura, Colombia, May 28, 1923, by O. F. Cook and J. W. Hubbard (no. 169).

The outstanding features of this plant are the small, narrow, free, involucre bracts, the small round bolls, the numerous 2-lobed leaves, and the pubescence of simple hairs.

#### *Gossypium quinacre* sp. nov.

Plant moderately robust, about 2 meters high, of rather low, spreading "herbaceous" habit, main stalk short-jointed, bearing numerous short-jointed horizontal vegetative branches, and strong fruiting branches, attaining 85 cm., with rather long basal joints; also with fruiting branches near the ground on the vegetative branches; foliage and general appearance of the plant suggesting Sea Island cotton.

Leaves large, subglabrous, with pale venation, surface strongly upfolded between veins; lobes 5 to 7, with long acuminate points, none of the leaves 3-lobed; the forelobes often equal to the midlobe; auricles large, usually overlapping; midlobes occasionally with teeth, but these confined to a few leaves of the main stalk, the teeth usually above the middle of the lobes; length of large leaf on midvein 23 cm., on greatest expansion of auricle 25 cm., width on points of forelobes, 33 cm., on points of sidelobes 25 cm., length of petiole 16 cm. Leaf nectaries, only 1 on fruiting branch leaves, 1 to 3 on main stalk and vegetative branch leaves, even large 7-lobed leaves sometimes with only 1 nectary; midvein nectaries long, elliptical to lanceolate, located about 2 cm. from base, forevein nectaries very small, ovate, located about 1 cm. from base. Petioles papillate with prominent oil-gland. Stipules long, linear, but on fruiting branches sometimes broad and strongly curved, occasionally bidentate.

Involucre bracts very large, ovate, deeply cordate, the auricles slightly curved inward, but not overlapping; the short inner margins united, usually for only 1 or 2 mm., sometimes for 4 or 5 mm.; teeth 13 to 19, very long and slender, attaining 3.5 cm. on bracts with total length of 8 cm.; three middle teeth not prominent, margins of auricles entire; bractlets of common occurrence; outer nectaries prominent, subrotund; inner nectaries subtriangular; pedicels rather short, attaining 3.5 cm., triangular, with deep grooves running down the angles, making six nearly equal grooves and ridges; calyx short, with five very shallow sinuate lobes.

Flowers very large, not opened beyond a cylinder, 9 to 9.5 cm. from the outer nectary to end of corolla; petals pale yellow, with small petal spots.

Bolls oblong-oval, abruptly acuminate, 3-locked or often only 2-locked, the surface somewhat lighter green, smoother and more even, and with smaller and more scattered punctations than in related species; mature open bolls not present.

Type in U. S. National Herbarium nos. 1,282,039, 1,282,040, and 1,282,041,

collected from a single plant at Bahia de Caraquez, Ecuador, May 12, 1926, by O. F. Cook and J. W. Hubbard (no. 112).

The plant grew among ivory-nut shells, and was so healthy and vigorous that a full development of vegetative branches would be expected, as well as full numbers of leaf-lobes, nectaries, and carpels, so that the peculiarities in such characters appear significant. The vegetative branches, though numerous, did not behave like the erect or strongly ascending, stiff woody shoots of the "tree" cottons, but showed a modified fruiting habit, soon spreading into horizontal or decumbent positions, with flowers and bolls near the ground, like a cultivated "annual" or "herbaceous" type of cotton. There were 18 vegetative branches, the lower about 1.5 meters long, the upper 1 meter, also vegetative shoots on some of the lower fruiting branches, from the basal or second joints. On a fruiting branch 85 cm. long, eight successive joints measured in centimeters as follows: 22, 10, 10, 9, 9, 10, 10, 3. The main stalk internodes and those of the vegetative branches were 4 to 5 cm. long.

The outstanding features are the spreading low-fruiting habit, the absence of 3-lobed leaves, the slight development of nectaries, both on the leaves and the involucre, the narrow oblong bolls, often with only 2 locks; and the very large involucre bracts greatly exceeding the bolls, with the teeth very numerous and long, and with the auricles deep and broad. Considered as a member of the South American series, the characters presented by this plant may afford an indication of the relationship of the Sea Island type of cotton.

Since only one plant of this type was seen, it may have been a hybrid, but it presents such an interesting series of characters that a description seems warranted. The large leaves and bracts, and the narrow, few-locked bolls, are not inconsistent with hybridism, but the rather spreading habit and the specialized character of the vegetative branches, short-jointed, and producing numerous fruiting branches near the ground, do not suggest a hybrid.

#### *Gossypium evertum* sp. nov.

Plants large and spreading, attaining a height of 10 or 12 feet, with stalks 3 or 4 inches in diameter at base; foliage dense, light green, glabrous; fruiting branches many-jointed, the basal joint usually long, from 12 to 18 cm., other joints from 2 to 5 cm.

Leaves a rather light, fresh-green, glabrescent; very young leaves sparingly covered with short stellate hairs below; lobes 3 to 5, usually 5, rather long, with long-acuminate points; sidelobes usually at right angles to the midlobes; auricles short, sinus open, basal curves or margins of the auricles often distinctly undulate; veins pale, prominent below; surface often bullate between veins near base; length of large 5-lobed leaf, on the midvein 18.5 cm., on the greatest expansion of the auricle 21 cm., width on points of forelobes 28 cm., width on points of sidelobes 20 cm.; leaf nectaries small, usually 3 on leaves of the main stalk and vegetative branches, but only one on leaves of fruiting branches; nectaries of the midveins rather large and deep,

with prominent rims, located about 1.5 cm. from base; nectaries of foreveins very small, 3 to 5 mm. from base, usually ovate or oval, sometimes reduced to a small narrow groove; stipules large, linear, fugacious, usually shorter and broader on the fruiting branches, often very irregular and unequal, one of a pair sometimes twice as large as the other.

Involucres light green, glabrous; bracts oval or ovate, subcordate, strongly concave or everted, exposing much of the inner surface, which is pale green and glossy; teeth 9 to 13, irregularly arranged, the 3 middle teeth not prominent; auricles very short, with entire margins, the inner margins regularly united; no trace of bractlets found; outer nectaries rather large, rounded or transversely oval, prominent above the surrounding surface, especially before flowering; inner nectaries rather large subtriangular; pedicels short, distinctly triangular, with a small groove running down each ridge; calyx, truncate or with only slight indications of lobing.

Flowers large, cylindrical, not opening widely; petals broad and widely overlapping, with a distinct lateral lobe or tooth at the point of the section exposed in the bud, pale yellow with small red petal spots and numerous golden yellow oil-glands, the venation very distinct; staminal column 2.5 cm. long, with small scattering yellow oil-glands; stamens not numerous, filaments rather short, in five distinct rows; anthers pale, medium size, pollen deep yellow; style long, stigma exerted about 1 cm.; oil-glands of styles in two widely spaced rows, the glands in one row alternating with those in the other.

Bolls 3-locked, about 5 cm. long by 2 cm. wide, narrowly conic-oval, acuminate, oil-glands large and scattering, surface slightly rugose, shining; ripe bolls open widely, the points curving backward, forming sharp hooks; seeds per lock 7.

Seed small, dark brown, naked at the base or nearly so, with a narrow band of short brownish fuzz near the middle, and sometimes small tufts of fuzz at either end; lint faintly tinged with buff, about  $1\frac{1}{4}$  inches in length, slightly harsh; the lint is confined to the upper portion of the seed, from the band of fuzz to the tip.

Type in U. S. National Herbarium nos. 1,282,028 and 1,282,029, collected at Buenaventura, Colombia, April 30, 1926, by O. F. Cook and J. W. Hubbard (no. 63).

The distinctive characters are the light, fresh-green glabrous foliage, the strongly everted involucre, the lateral petal tooth and the distribution of fuzz and lint on the seed. The lower part of seed usually is entirely naked, the fuzz mostly restricted to a belt around the seed, where the lint begins.

The open involucres, with strongly everted bracts, may be considered as an adaptation to a humid tropical climate. Closed involucres appear disadvantageous, especially under humid conditions, because of the protection afforded to insect pests and plant diseases. Diseases like anthracnose and bacterial boll-rot are very common and destructive in tropical America.

#### *Gossypium calycotum* sp. nov.

Plants large, spreading, 8 to 10 feet high, the large fruiting branches with long basal joints like Egyptian cotton, though the foliage appears more like Upland cotton.

Leaves light green, simple or 3 to 5 lobed, the upper surface subglabrous, the lower surface rather densely covered with very short stellate or tufted

hairs; lobes rather short, subtriangular, acuminate, sidelobes often represented only by a tooth; sinus between lobes rounded and open, the surface of the leaf usually flat; sidelobes often extending backward at an angle of about 50 or 60 degrees to the midvein and closing the basal sinus, though the auricles are rather short; length of blade on midvein 19 cm., on greatest expansion of auricle 24 cm., width on points of forelobes 30 cm., on points of sidelobes 20.5 cm.; veins prominent below; nectaries usually 3, appearing as long narrow slits, those on midvein located about 2 cm. from base, and attaining about 5 mm. in length, about twice as large as those on foreveins; petioles papillate, especially near base of leaf; stipules rather large, fugacious, very broad and strongly curved on fruiting branches, often broader than long, sometimes toothed.

Involucral bracts large, with 10 to 13 rather large teeth; at base cordate with an abrupt, deep sinus formed by the straight united inner margins of the auricles extending back along the pedicel for 8 to 10 mm.; lower margins open and slightly flared, forming nearly a right angle with the inner margins, lateral margins entire, often to the middle of the bracts; calyx rather short, subtruncate, with very slight indications of lobing; pedicels short, stout, triangular, 2 to 2.5 cm. long; outer nectaries subrotund, rather large, prominent, inner nectaries subtriangular or trapezoidal, usually slightly longer than broad; large auriform crests subtending and connecting the inner nectaries, the crests appearing occasionally like bractlets, but usually as ruffle-like appendages irregularly curled or rolled outward, extending around the base of the calyx, the bractlet-like crests apparently of the same texture as the calyx, with numerous small black oil-glands, but the more continuous crests with lower surface very pale and usually without oil-glands. Flowers not seen.

Bolls of medium size, attaining 5 cm. long, rather broadly conic-ovoid, with stout acuminate points, the surface rather closely and irregularly pitted; locks 3, with 9 or 10 seeds per lock.

Seeds dark brown, with a small tuft of light brown fuzz at base. Lint white, about  $1\frac{1}{4}$  inches long.

Type in U. S. National Herbarium nos. 1,282,033, 1,282,034, and 1,282,035, collected from a single plant at Esmeraldas, Ecuador, May 11, 1926, by O. F. Cook and J. W. Hubbard (no. 105).

The remarkable broad auriform crests extending around the base of the calyx between the inner nectaries are the outstanding feature of this species. The crests are not parallel to the insertions of the bracts, but rise rapidly, usually to about half the height of the calyx, and sometimes to the full height, forming a semicircle between two of the inner nectaries. In many cases the crests are interrupted and occur as small separate sections between the nectaries, but always on a curve, like a complete crest. Below the complete crests the surface of the calyx is pale and without oil-glands.

#### *Gossypium auritum* sp. nov.

A large spreading perennial shrub, attaining 8 to 10 feet in height and 3 to 4 inches in diameter at base, the large fruiting branches with long basal joints, often attaining 18 to 20 cm.; foliage deep green, subglabrous.

Leaves large, usually with 5 lobes, even on rather small leaves; midlobes large, ovate, oblong, abruptly acuminate, often apiculate; the forelobes large sometimes nearly equal to the midlobes; the sidelobes usually short,

broadly triangular; auricles ample, often overlapping; texture rather heavy, upper surface glabrous, strongly upfolded between the bases of the primary veins; callus and veins whitish, lower surface pale green, with few stellate hairs; length of large leaf on midvein 19 cm., on the greatest expansion of the auricle 24 cm., width on points of forelobes 30 cm., width on points of sidelobes 23 cm.; leaf nectaries short, broadly ovate or cordate, sometimes 3, usually only one even on large 5-lobed leaves, inserted low on the midvein, often 1 cm. or less from the base, nectaries of foreveins sometimes only 3 to 4 mm. from the base; petioles long, stout, attaining 21 cm. in length, with a distinct pulvinus at each end, the upper pulvinus papillate; stipules large, fugacious, linear on vegetative branches, much broader on fruiting branches, sometimes nearly as broad as long, and strongly curved, occasionally bidentate.

Involucral bracts large, subrotund, broadly ovate; the auricles unusually large and broad, united only slightly at base, the inner margin strongly curved, meeting or overlapping across the pedicel, thus forming a complete circle around the outer nectary; teeth rather small, usually 17, sometimes 19 or 20, the margins of the auricles entire; bractlets often present; outer nectaries very large, prominent, cuneate, inner nectaries large, triangular, with a border of black oil-glands; calyx with five distinct, very short, rounded lobes.

Flowers large, 7 to 8 cm. long, the petals pale yellow, with small petal spots; staminal column rather long, about 2.8 cm., naked section at base about 8 mm.; stamens numerous, filaments short, anthers small, light brownish; stigma exserted about 5 mm. above stamens, the apex divided for about 3 mm. into 3 distinct lobes.

Bolls large, attaining 6.5 cm. by 3 cm., ovate-oblong, abruptly acuminate; usually 3-locked, sometimes 4-locked, with 12 or 13 seeds per lock; fissures deeply grooved near the tip; surface rather dark green, shining, rather coarsely and deeply punctate, with the oil-glands distinct.

Seed small, brown, gradually narrowed to a sharp beak, with a long spur on the funicle, the raphe often quite prominent, irregularly covered with short brownish fuzz, usually longer and more dense towards each end, with irregular patches near center, in places almost naked; lint white, very fine, silky, about  $1\frac{1}{4}$  inches long, but rather sparse and uneven.

Type in U. S. National Herbarium nos. 1,282,036, 1,282,037, and 1,282,038, collected from a single plant at Esmeraldas, Ecuador, May 11, 1926, by O. F. Cook and J. W. Hubbard (no. 108). Specimens and photographs were also secured from a large plant in a door yard at Bahia de Caraquez, Ecuador.

The outstanding characters of the species are the deep broad auricles and numerous teeth of the involucral bracts, and the large 3-locked bolls containing 12 or 13 seeds per lock. The inner margins of the bract auricles often overlap across the pedicel, thus forming complete circles around the outer nectaries.

Several characters of this species suggest the Ica cotton described by Spruce from northern Peru, particularly the large bolls and the large numbers of seeds in each lock, but the bracts of the Ica cotton are described as "lacinate all round the margin," and the outer nectaries as "obsolete."